INPAINTING OF DENTAL PANORAMIC TOMOGRAPHY VIA DEEP LEARNING METHOD

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Hello!

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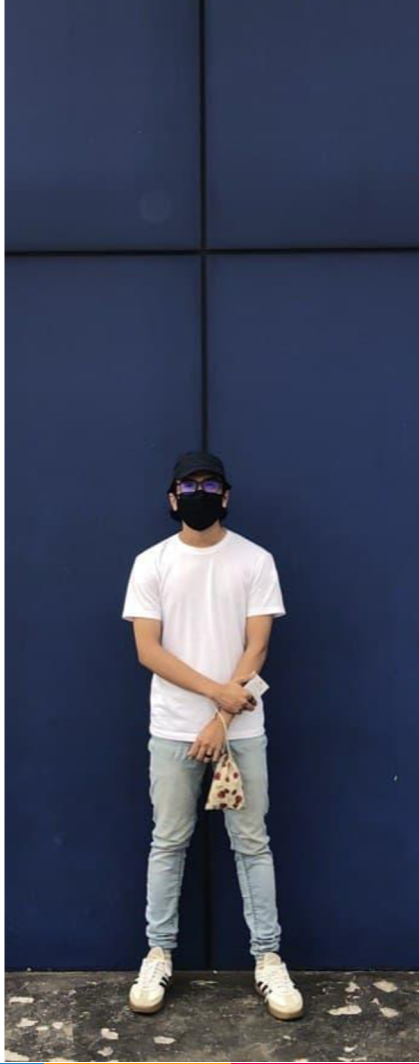
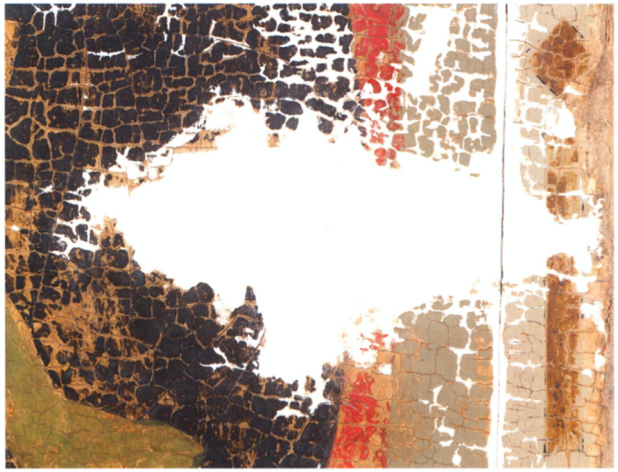


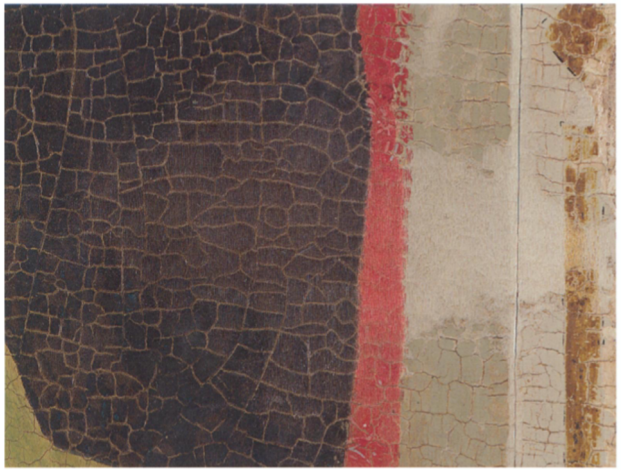
1. Inpainting & Artificial Intelligence

Art Restoration

Fig. 1. Workshop of Duccio di Buoninsegna (Ugolino di Nerio?), *The Virgin and Child Enthroned with Four Saints*, ca. 1305–10. Tempera on panel, 45¾ x 28⅜ in. (116.2 x 71.4 cm). Yale University Art Gallery, Gift of Hannah D. and Louis M. Rabinowitz, 1959.15.17. During current restoration



Inpainting



Hand Coloring

Print by Stillfried & Anderson between 1875 and 1885

Ai Generated Media

NVIDIA

Image Inpainting for Irregular Holes Using Partial Convolutions

Guilin Liu Fitsum A. Reda Kevin J. Shih Ting-Chun Wang
Andrew Tao Bryan Catanzaro

NVIDIA Corporation

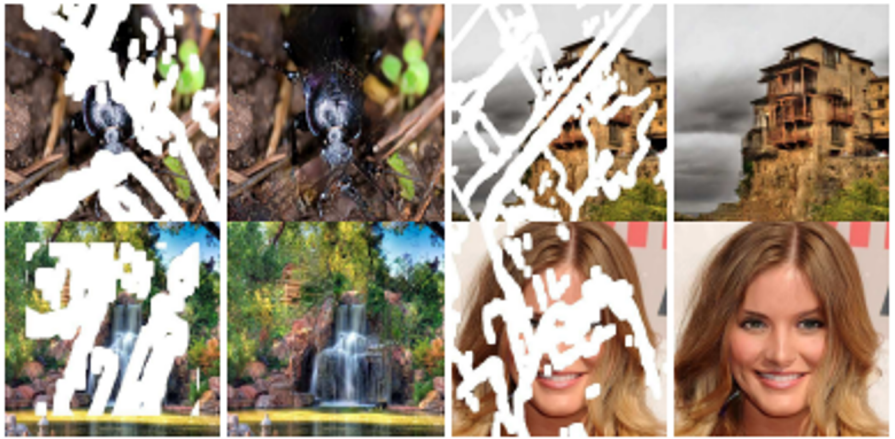


Fig. 1. Masked images and corresponding inpainted results using our partial-convolution based network.

2. Artifact In Medical Imaging

Medical Imaging

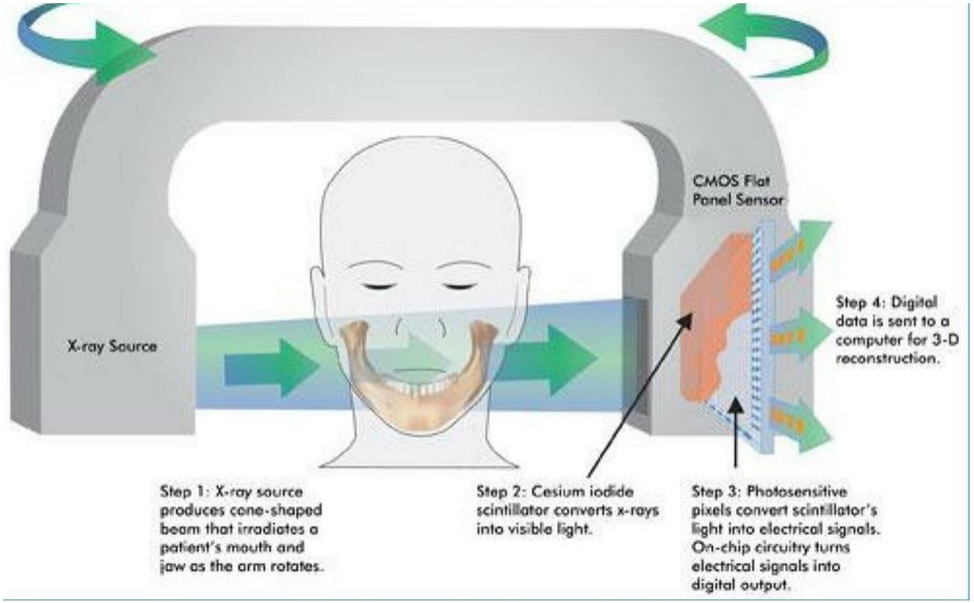
CT-Scan

Mammogram

X-Ray

CBCT

Cone-Beam CT


CMOS Flat Panel Sensor
X-ray Source
Step 4: Digital data is sent to a computer for 3-D reconstruction.
Step 1: X-ray source produces cone-shaped beam that irradiates a patient's mouth and jaw as the arm rotates.
Step 2: Cesium iodide scintillator converts x-rays into visible light.
Step 3: Photosensitive pixels convert scintillator's light into electrical signals. On-chip circuitry turns electrical signals into digital output.

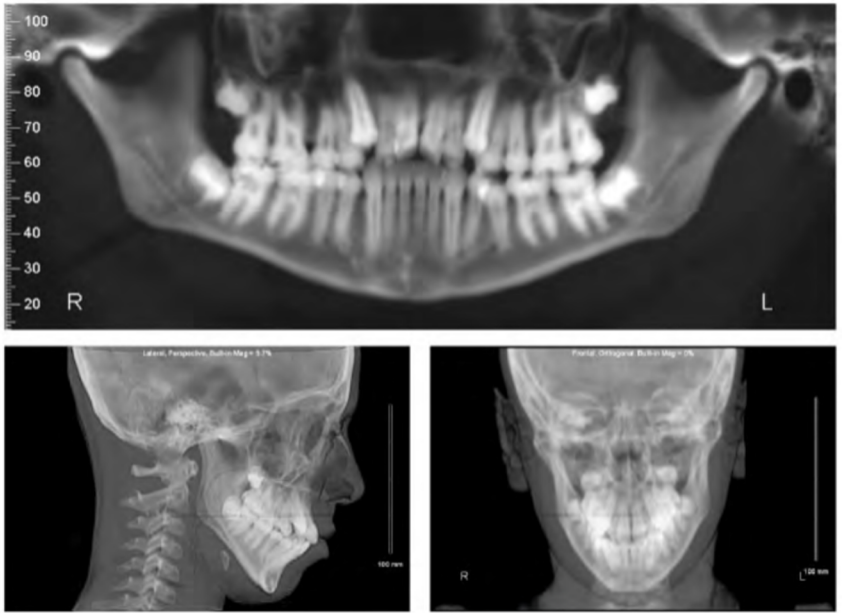
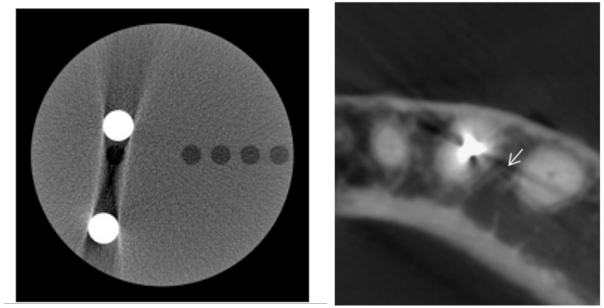
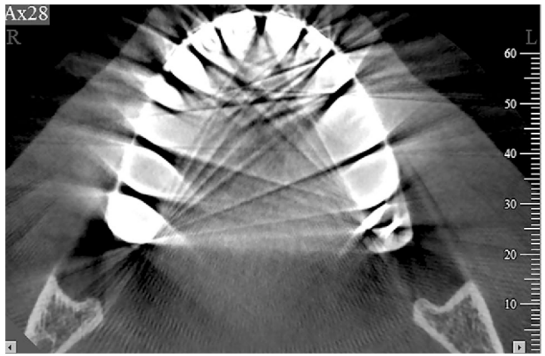
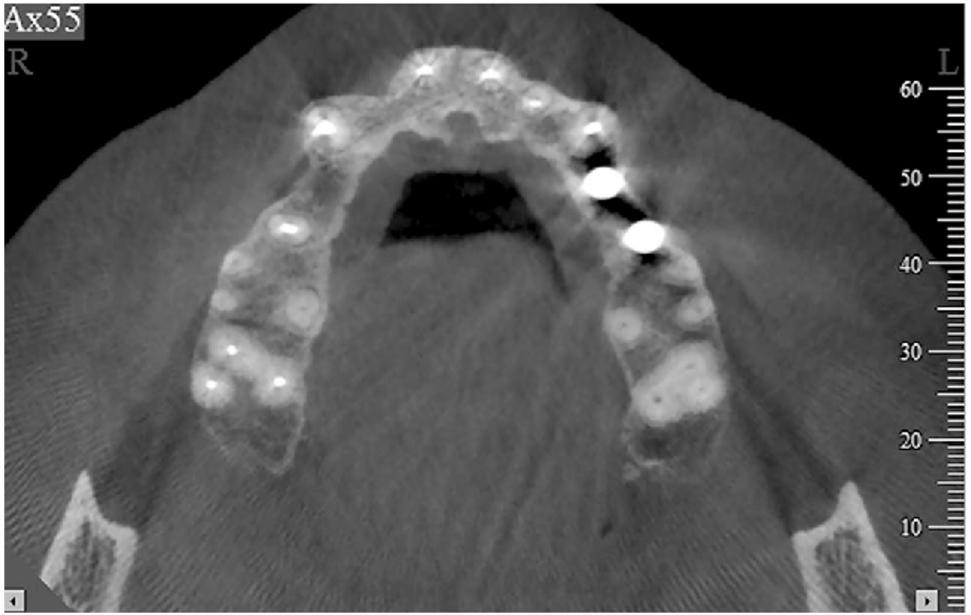

100
90
80
70
60
50
40
30
20
R
L

Image Artifact





Beam Hardening
(Metal implant)



Blurring due to motion

Image Artifact

Fig. 7. Ring artifact caused by calibration error.

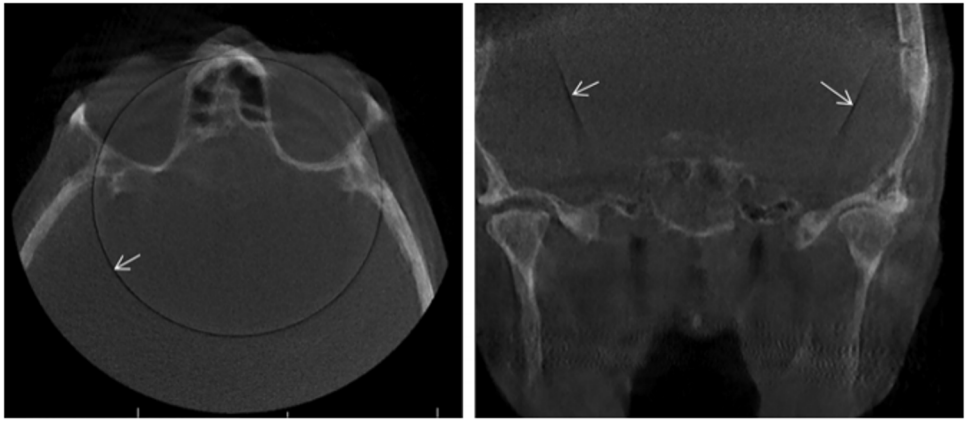


Fig. 8. Ring artifact caused by a dead dexel in the detector.

Image Anomaly

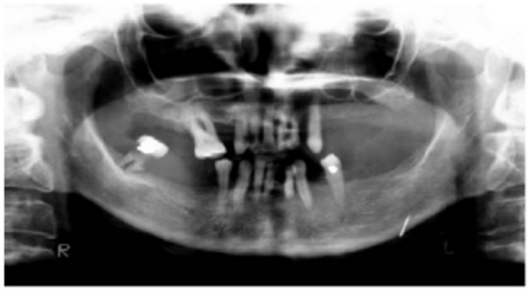


Figure 2. OPG of Case 2 revealing one needle at the left lower border of the body of the mandible.

Figure 3. OPG of Case 3 showing one needle superimposed at the right body of the mandible, distal to the left canine.

Open Journal of Stomatology, 2013, 3, 155-162 OJST
http://dx.doi.org/10.4236/ojst.2013.32028 Published Online May 2013 (http://www.scirp.org/journal/ojst/)

Susuk: Charm needles in orofacial soft tissues*

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[2]Department of Oral and Maxillofacial Surgery, University of Malaya, Kuala Lumpur, Malaysia
Email: #satbala@yahoo.com

Received 4 April 2013; revised 25 April 2013; accepted 8 May 2013

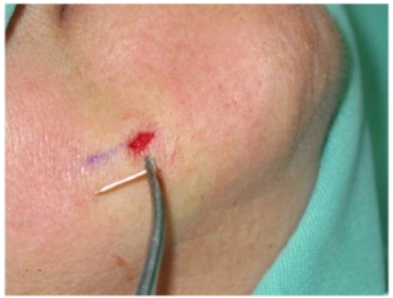
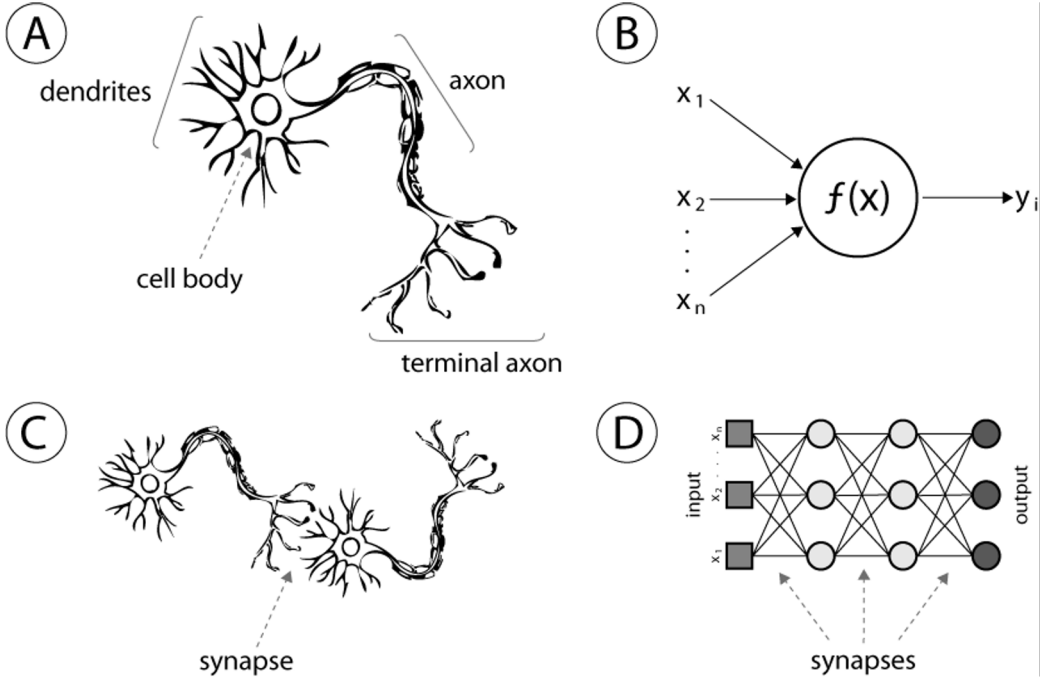


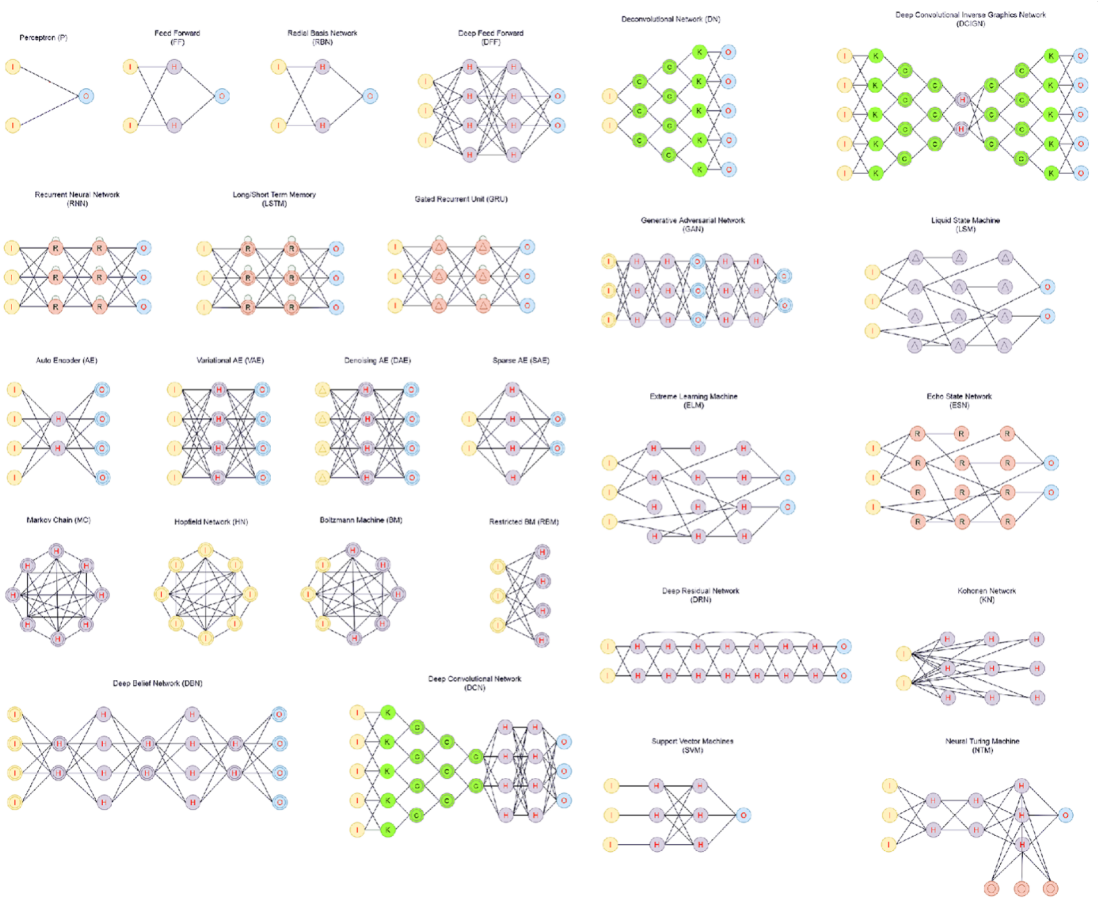
Figure 11. The removed susuk.

3. Medical Image Ai Inpainting

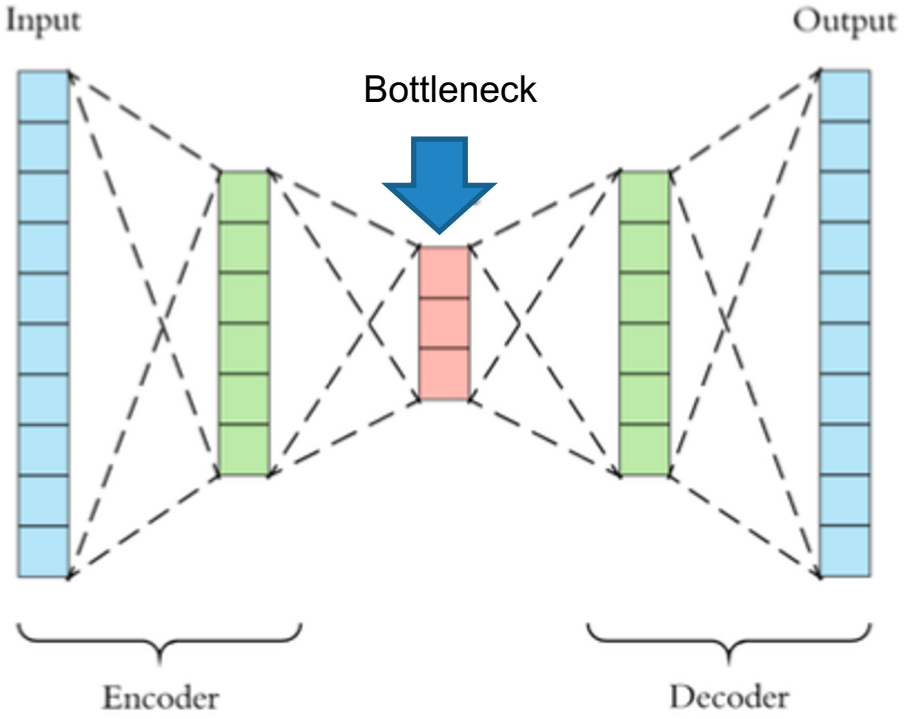
Artificial Neural Network



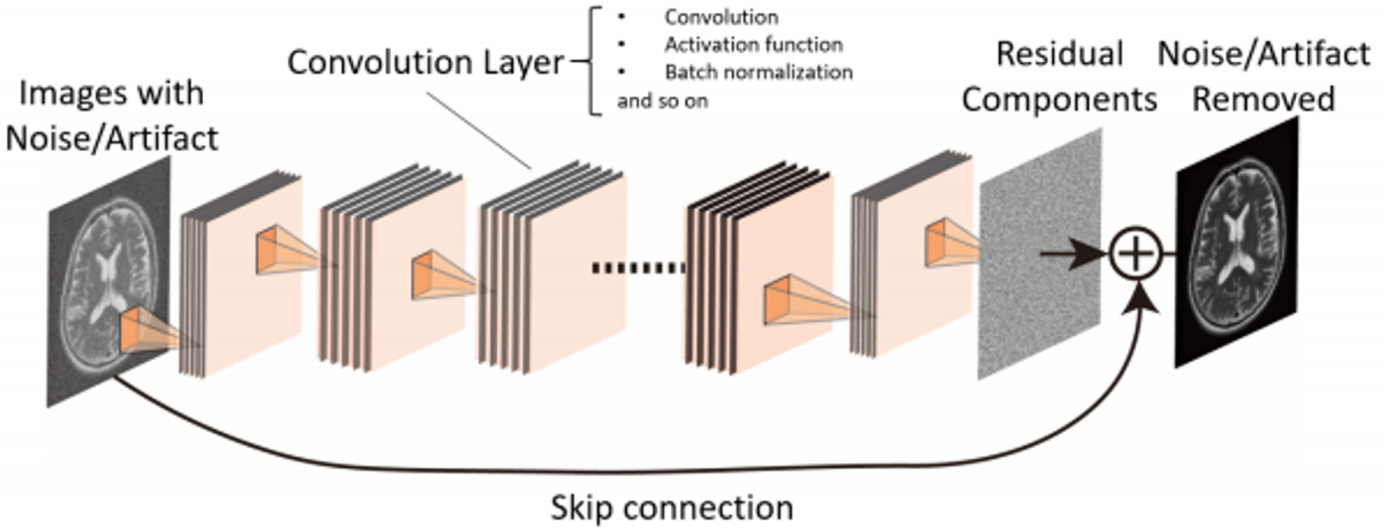
Artificial Neural Network



Autoencoder

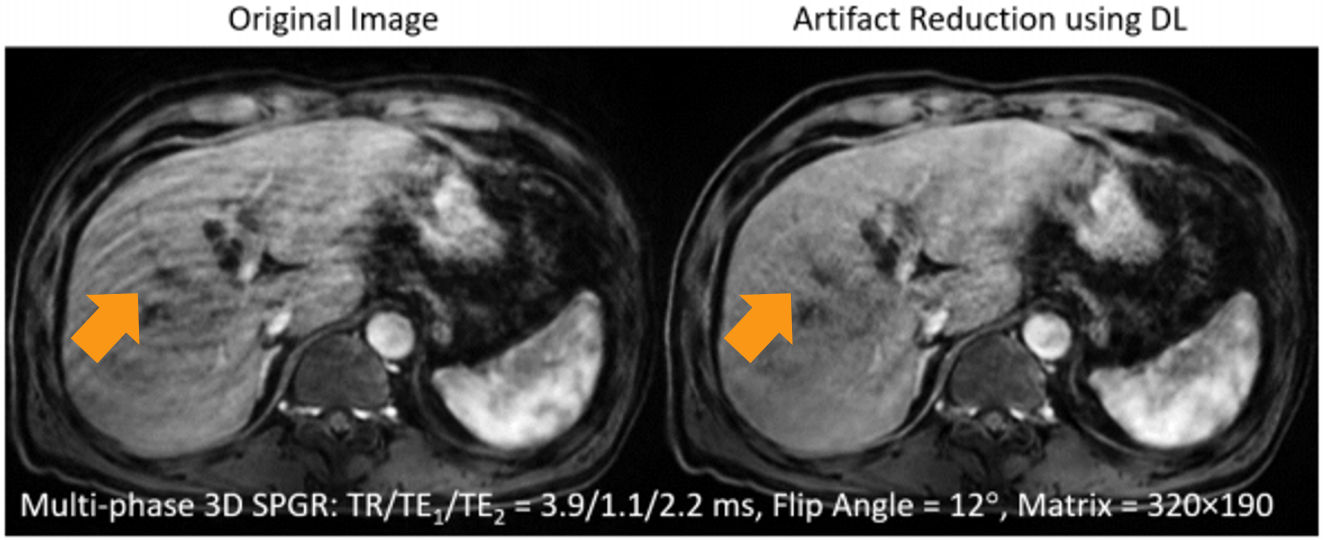


Artifact Correction



Tamada, D. (2020). Noise and artifact reduction for MRI using deep learning. *arXiv preprint arXiv:2002.12889*.

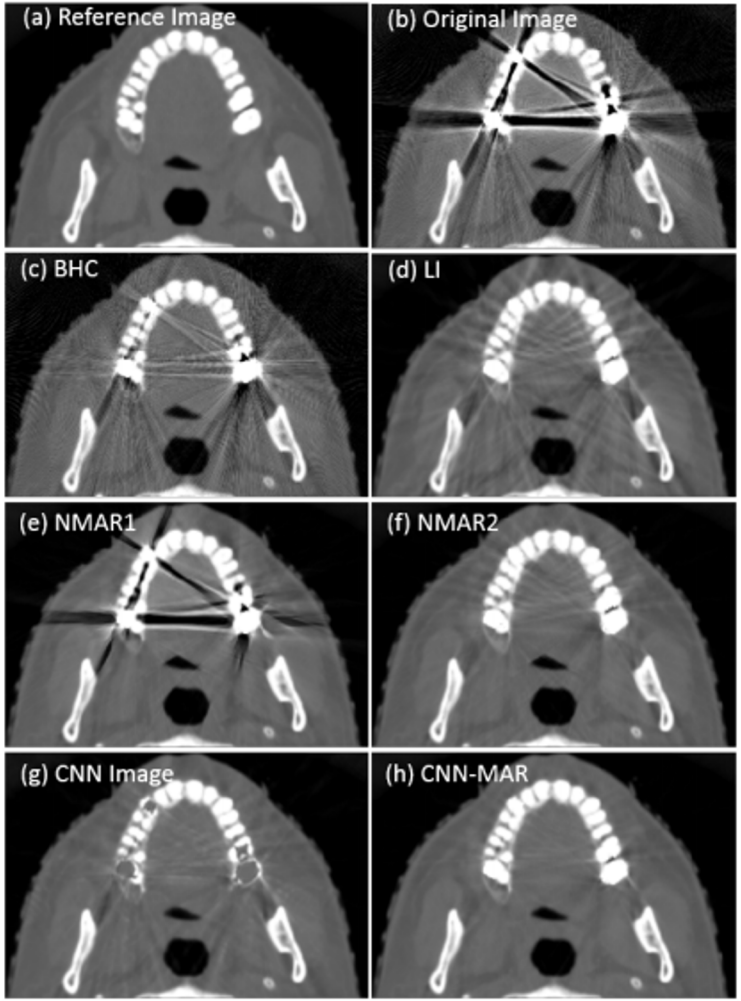
Artifact Correction



Tamada, D. (2020). Noise and artifact reduction for MRI using deep learning. *arXiv preprint arXiv:2002.12889*.

CBCT Correction

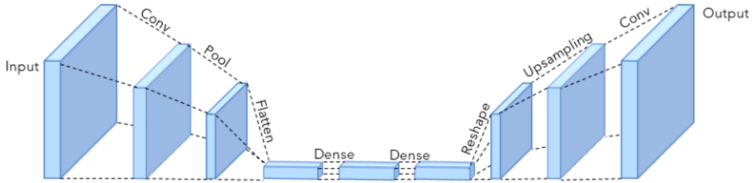
Zhang, Y., & Yu, H. (2018). Convolutional neural network based metal artifact reduction in x-ray computed tomography. *IEEE transactions on medical imaging*, *37*(6), 1370-1381.



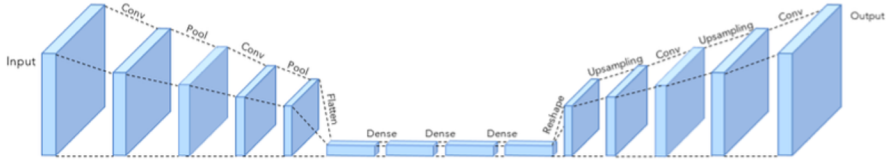
4. The Experiment

The Architectures

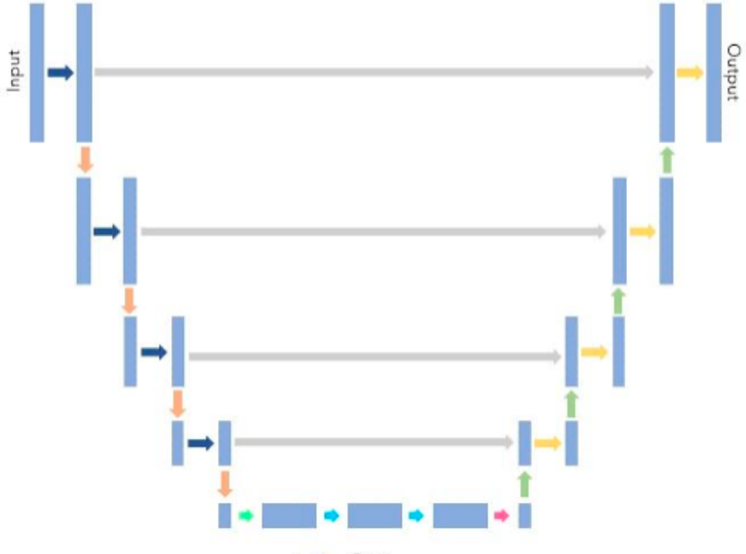
Shallow Autoencoder



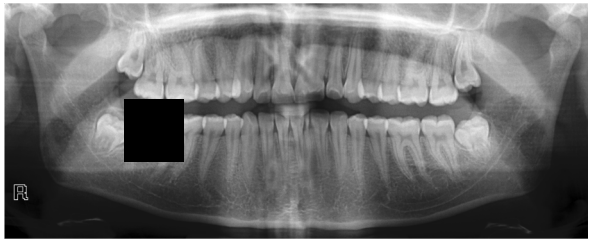
Deep Autoencoder

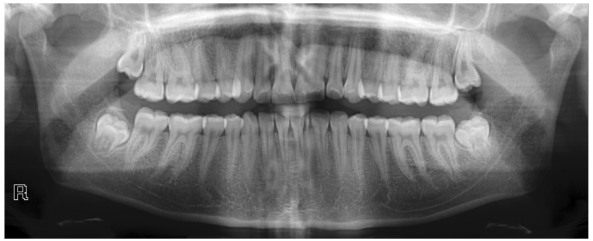


U-Net Autoencoder

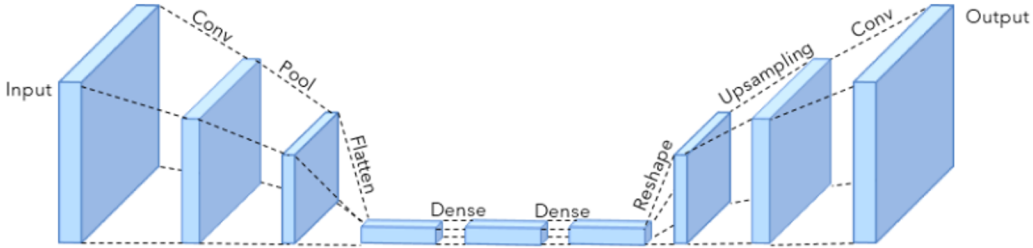


Model Training



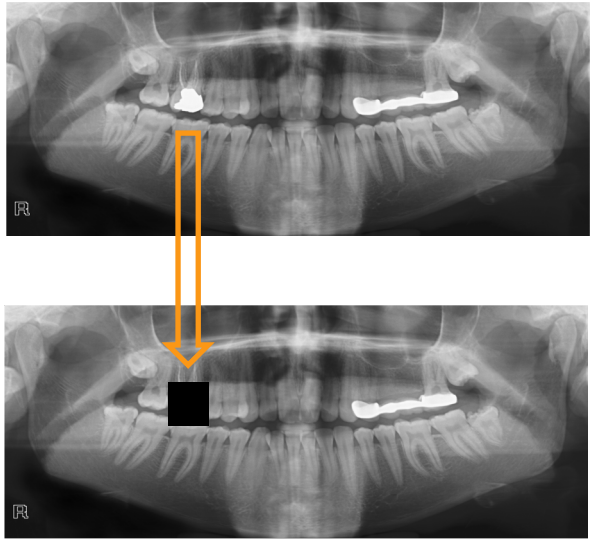


Input

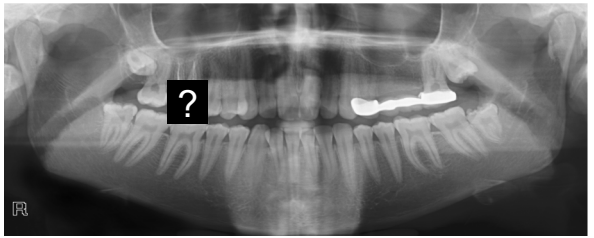


Output

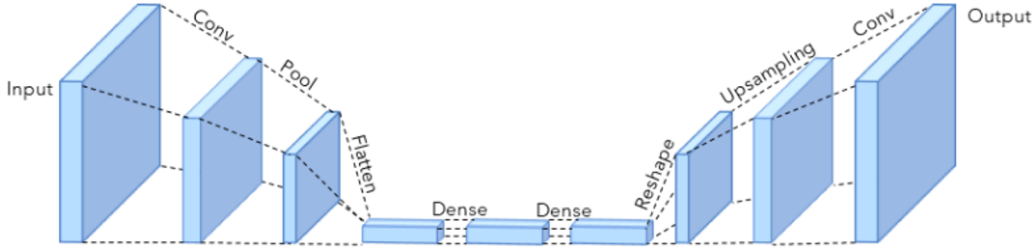
Model Testing



Original Imaging



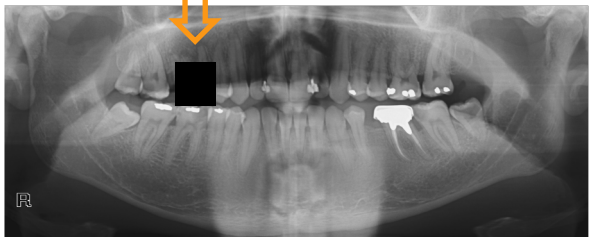
Input



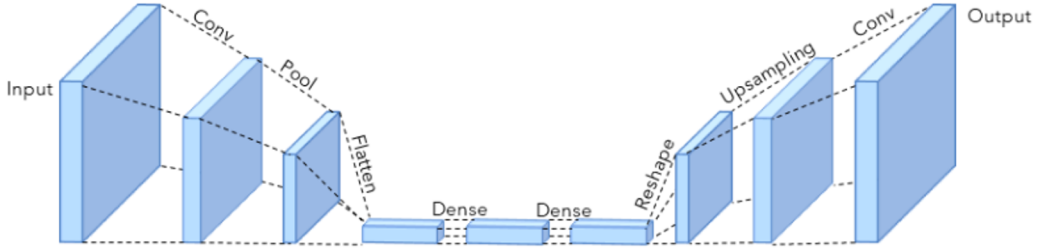
Output

Model Testing

Original Imaging



Input



Output

The dataset

- From Noor Medical Imaging Center, Qom, Iran
- 116 anonymized panoramic dental imaging
- 87 Image for training, 29 for testing

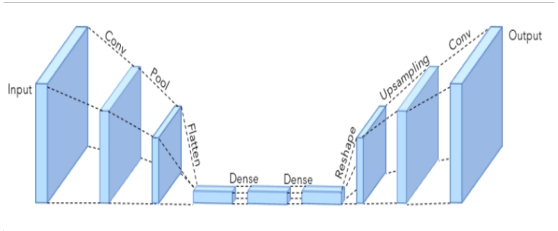
J Med Imaging (Bellingham). 2015 Oct; 2(4): 044003.
Published online 2015 Nov 18. doi: 10.1117/1.JMI.2.4.044003
PMCID: PMC4652330
PMID: 26587551

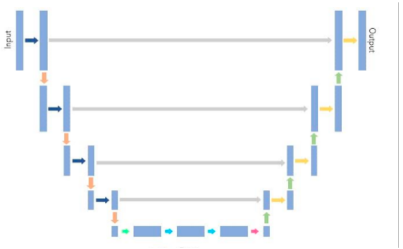
Automatic segmentation of mandible in panoramic x-ray

Amir Hossein Abdi,[a] Shohreh Kasaei,[a,*] and Mojdeh Mehdizadeh[b]

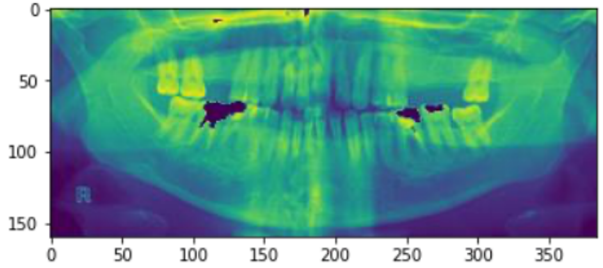
5. Result

Qualitative

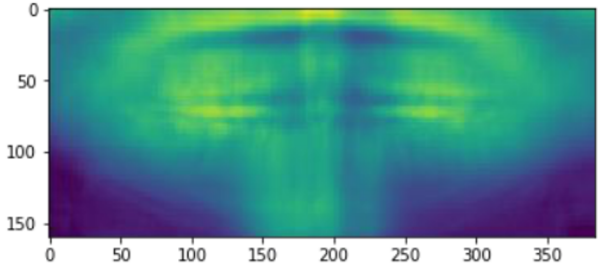




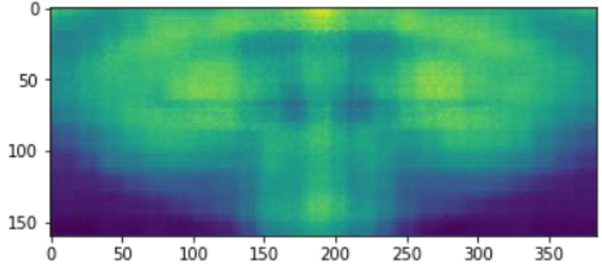
Nizam, S. (2021), Correction of Dental Cone Beam CT Artifact via Artificial Neural Network Inpainting Model, IIUM, Malaysia



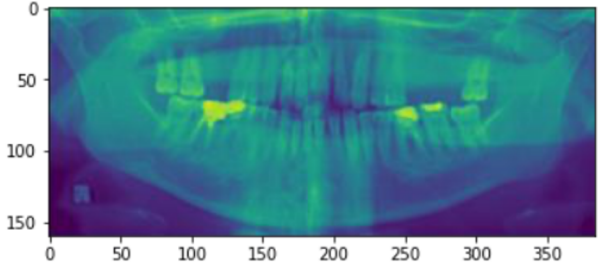
Input



Shallow Conv-AutoE

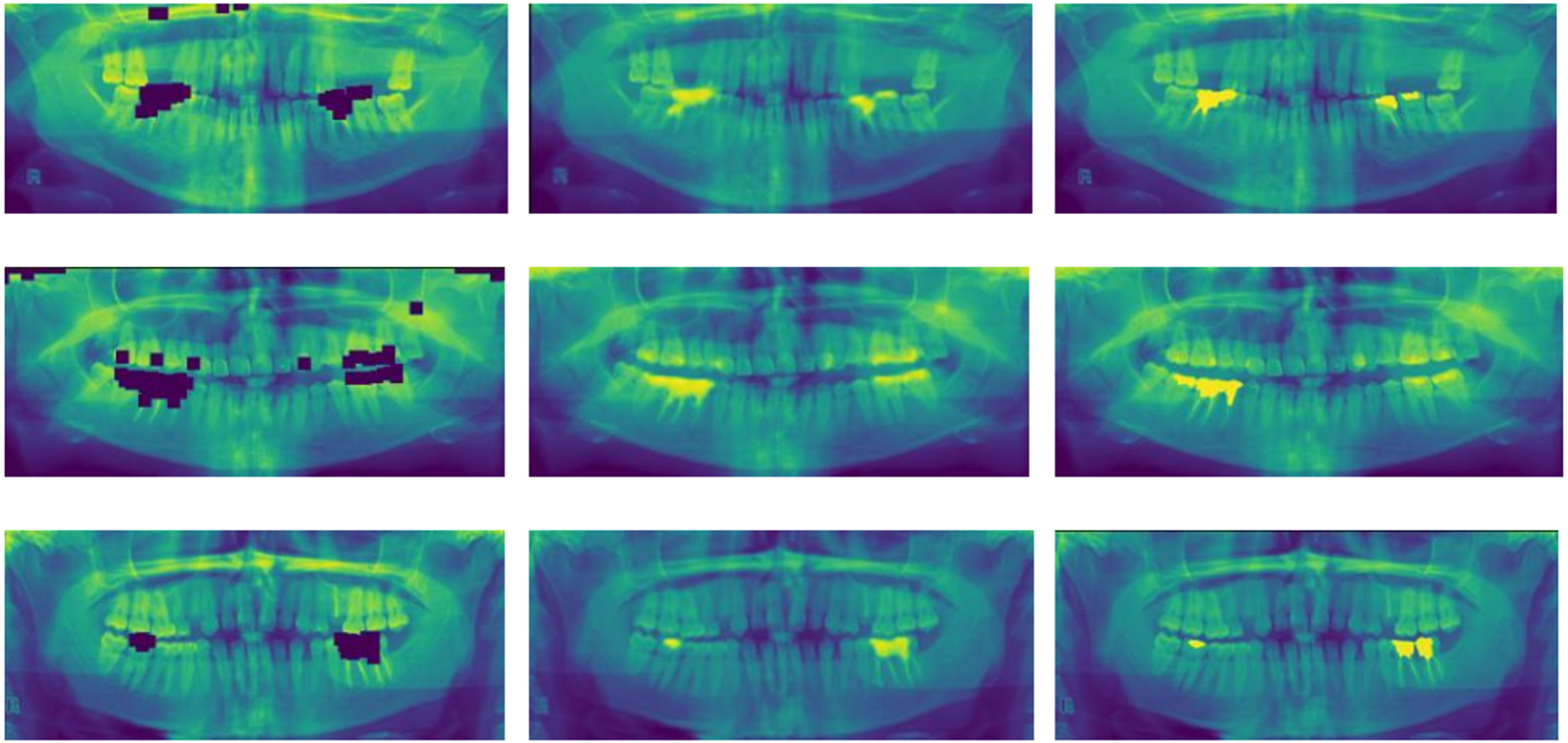


Deep Conv-AutoE



U-Net AutoE

U-Net Black-Box

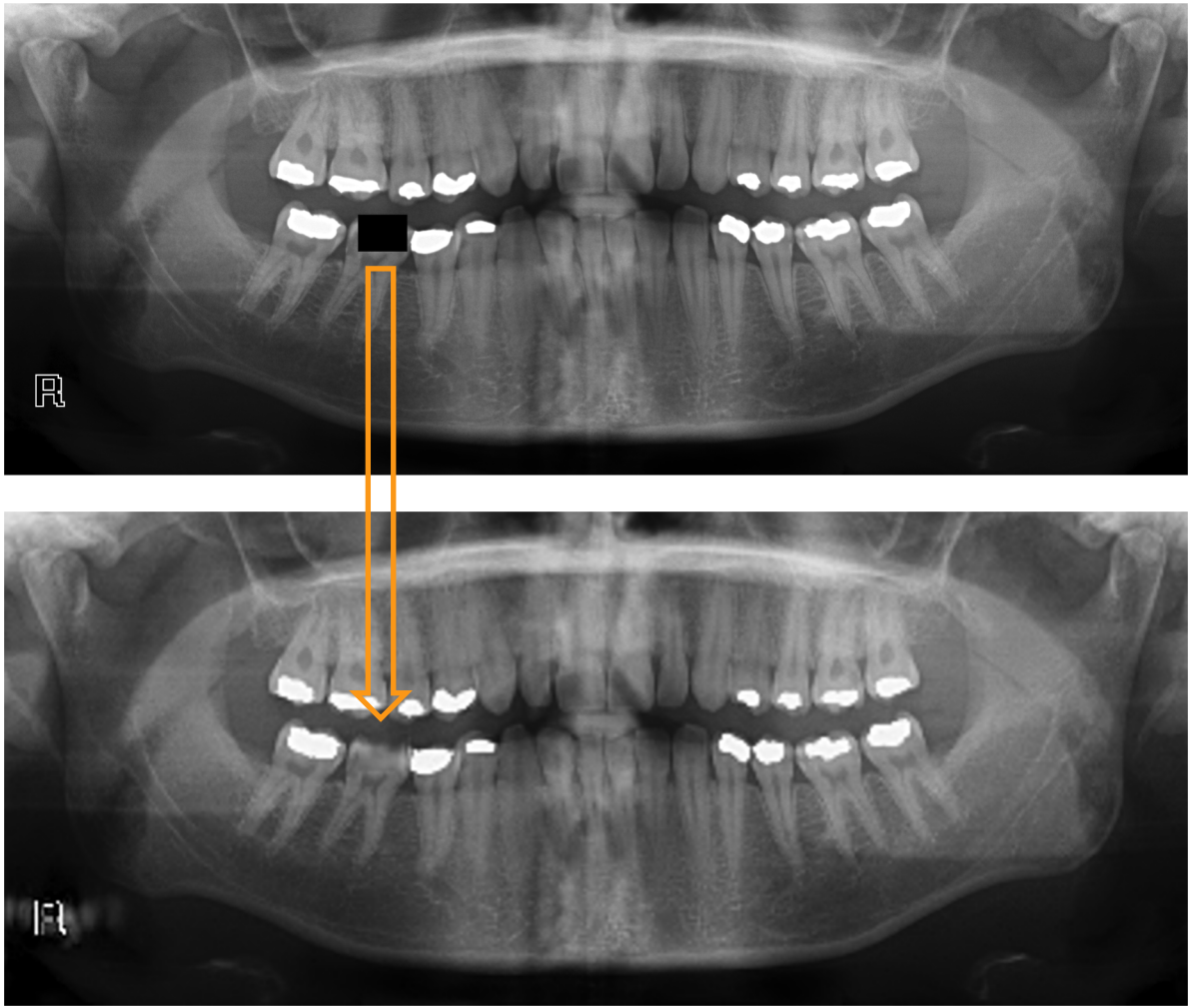


Quantitative

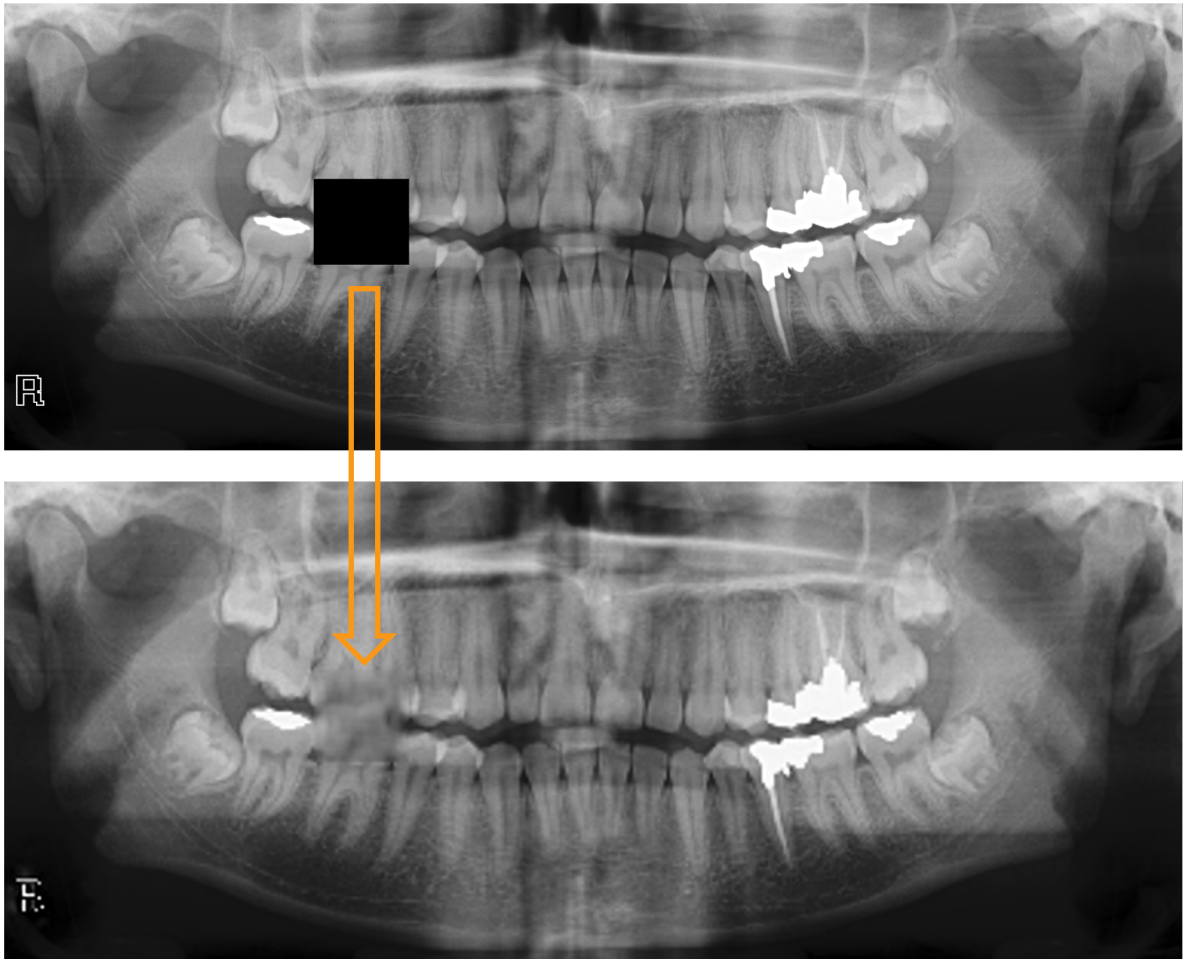
Models	MSE	SSIM
Shallow ConvAe	0.0100	0.6900
Deep ConvAe	0.0166	0.6405
U-net	**0.0003**	**0.9850**
U-net (black-box)	0.0010	0.9798

Nizam, S. (2021), Correction of Dental Cone Beam CT Artifact via Artificial Neural Network Inpainting Model, IIUM, Malaysia

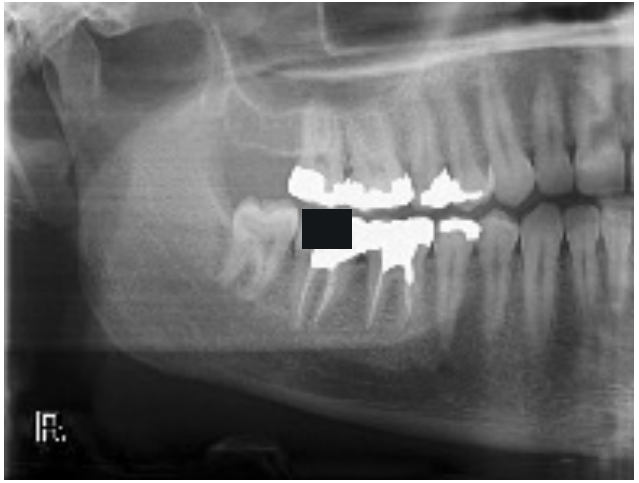
Limitations

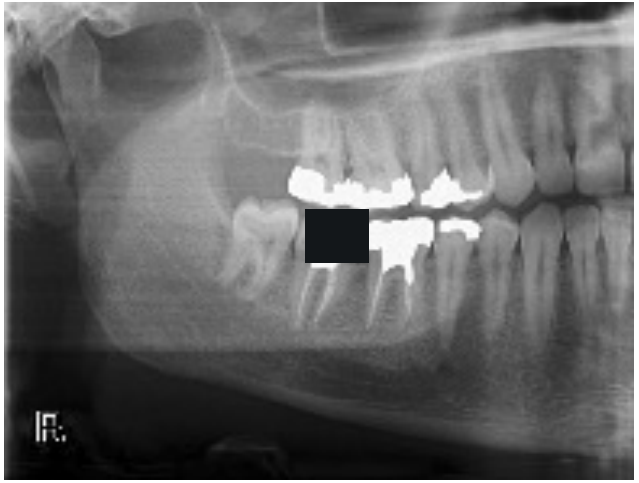


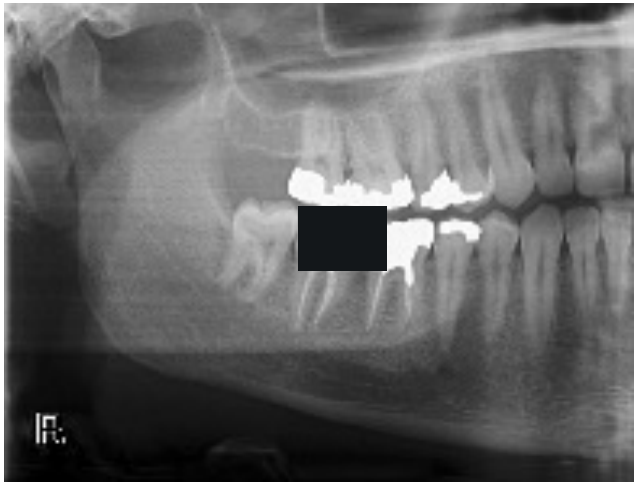
Limitations

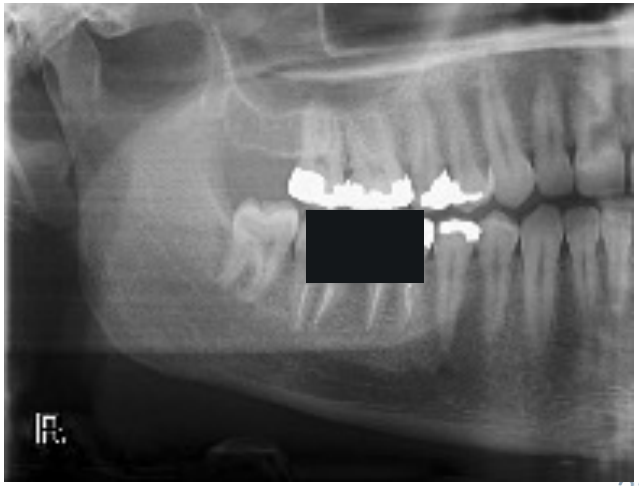


Limitations

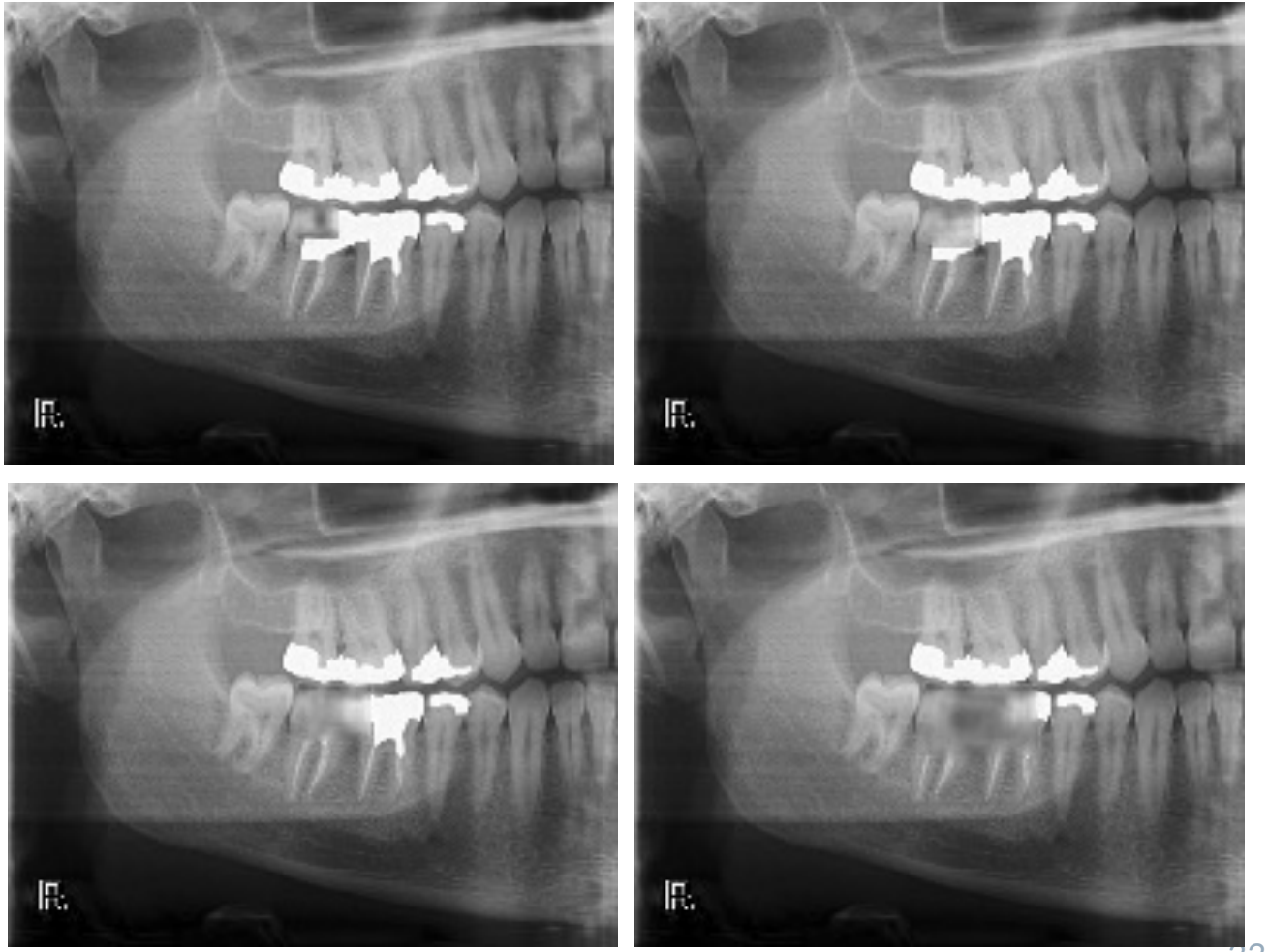




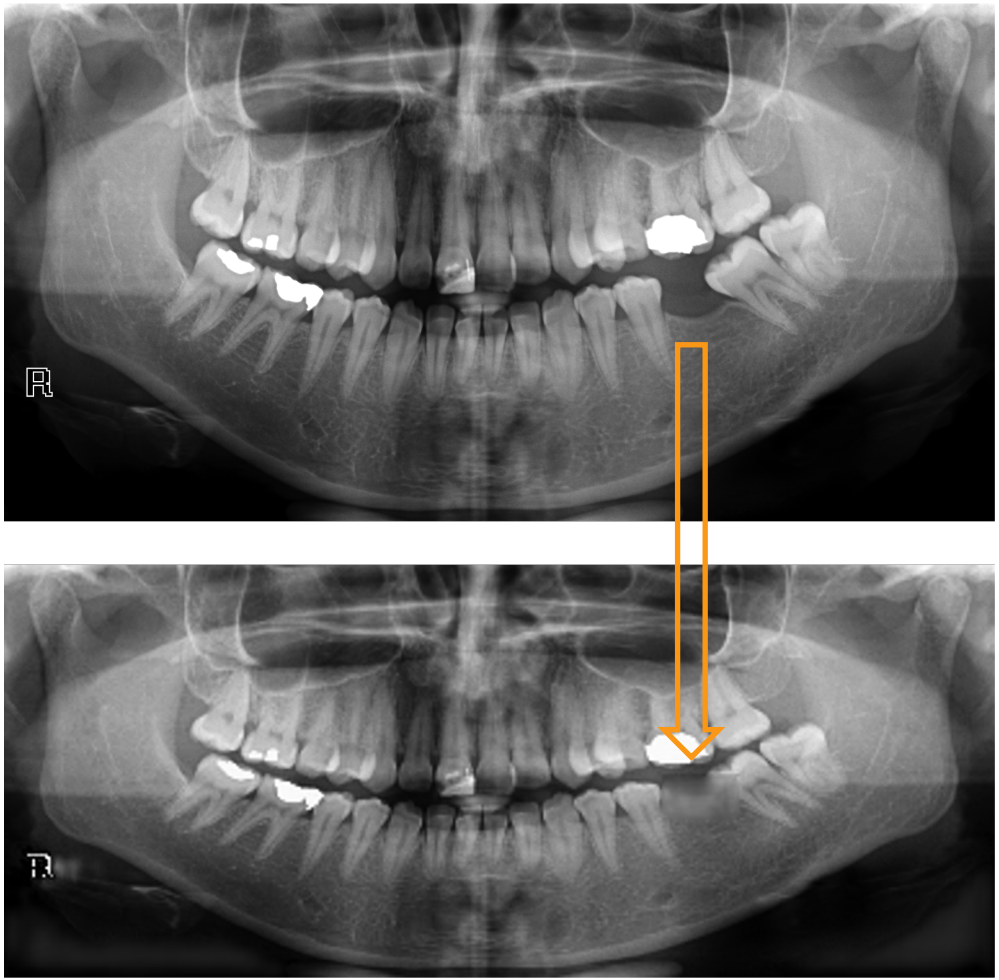




Limitations



Missing Tooth



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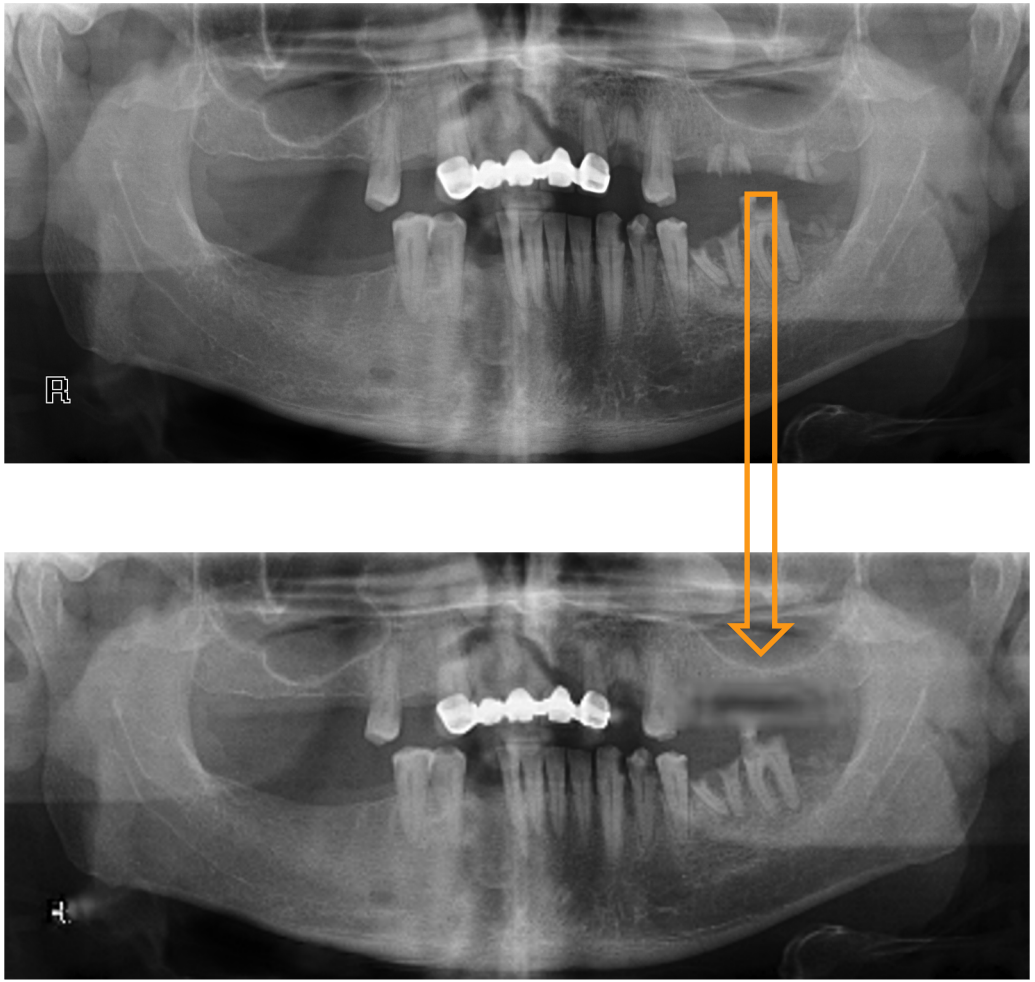

Conclusion

1. The outcomes showed that U-net model has the best performance in image reconstruction among the models. As this model benefits from the residual layer that overcome the vanishing gradient problem occurs in deep neural network.

2. However the model performance is limited by how large the correction box is. The bigger the correction box, the worse its performance become.

Thank You & Q-A